Oceanic Situational Awareness for the North Atlantic Corridor

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ICNS Conference
April 2004

Oceanic CNS Issues

- No radar/communications infrastructure
- Large, mandatory, procedural separations
- Projected increase in traffic load
- Limited expansion capacity

Oceanic CNS Amelioration

– Provide CNS “infrastructure” via AMSS

– Deliver timely surveillance information

– Shrink mandatory separations based on improved CNS

– Accommodate traffic expansion

QUESTION:

How do we model this?

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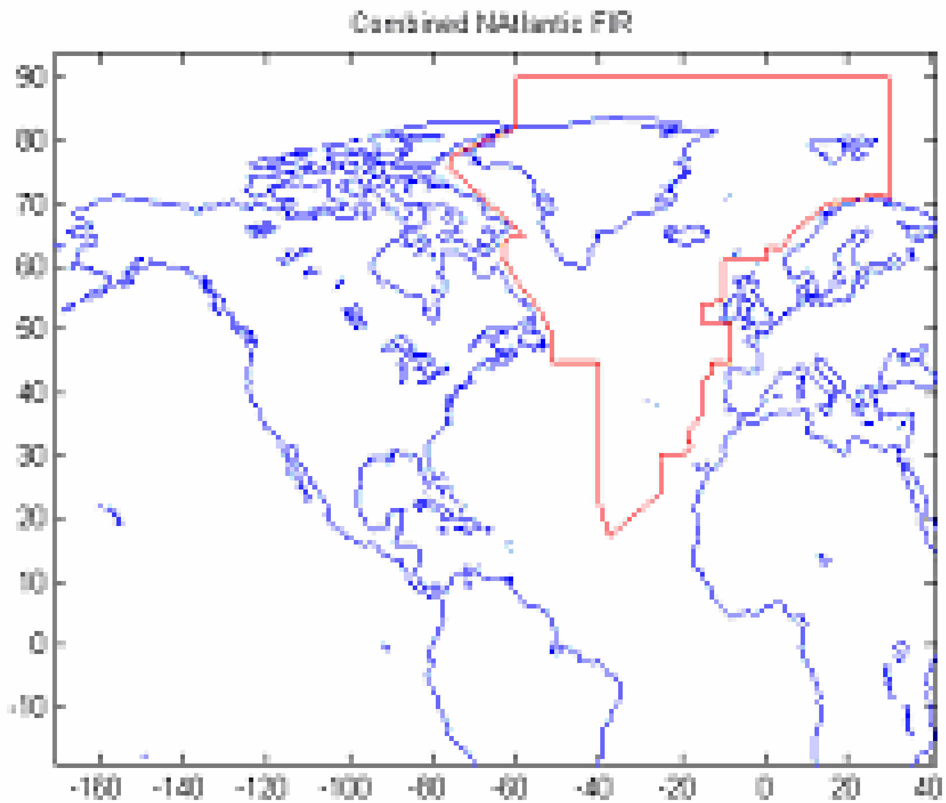
North Atlantic Flight Information Region



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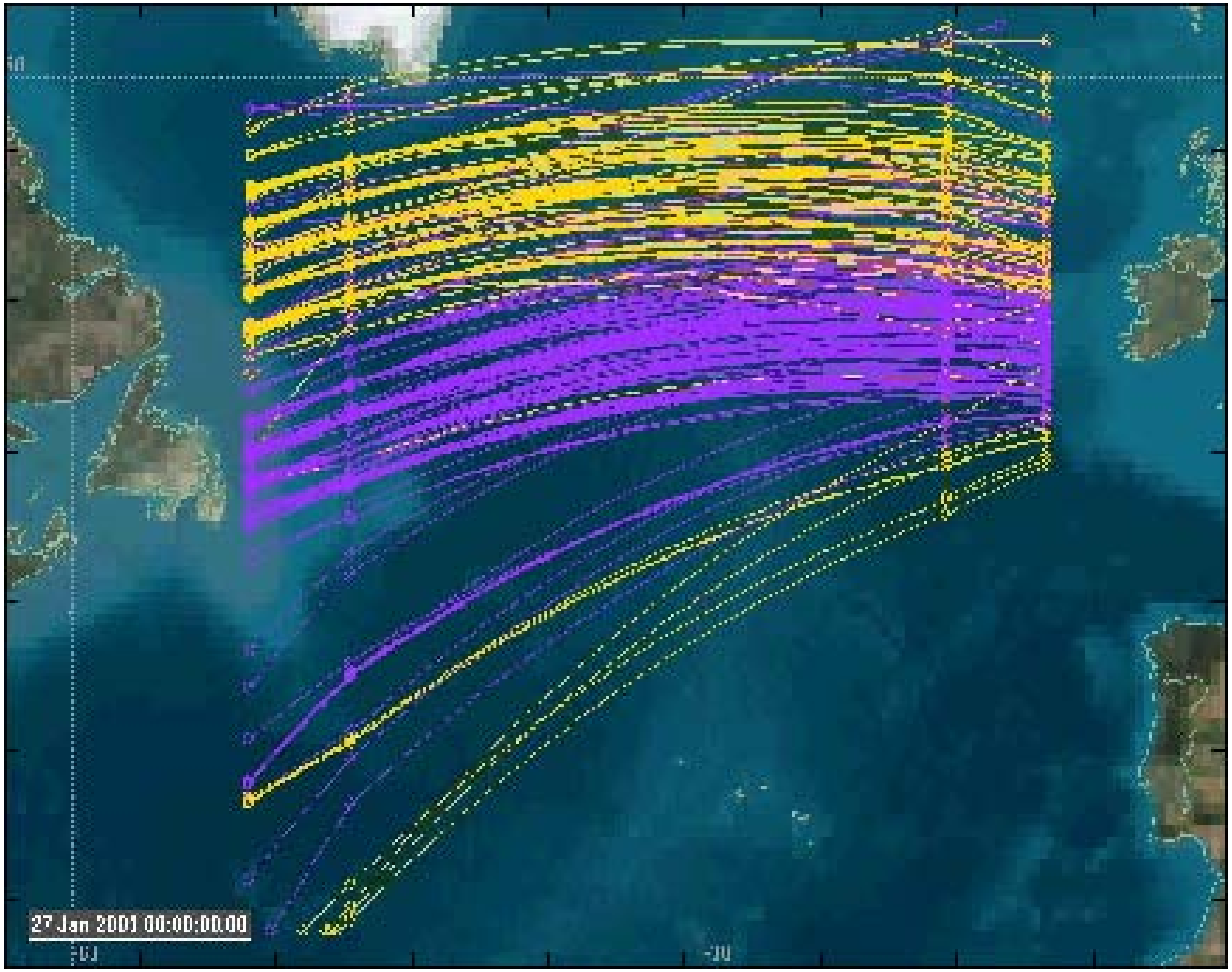
West Bound Flights in Gold



East Bound Flights in Purple

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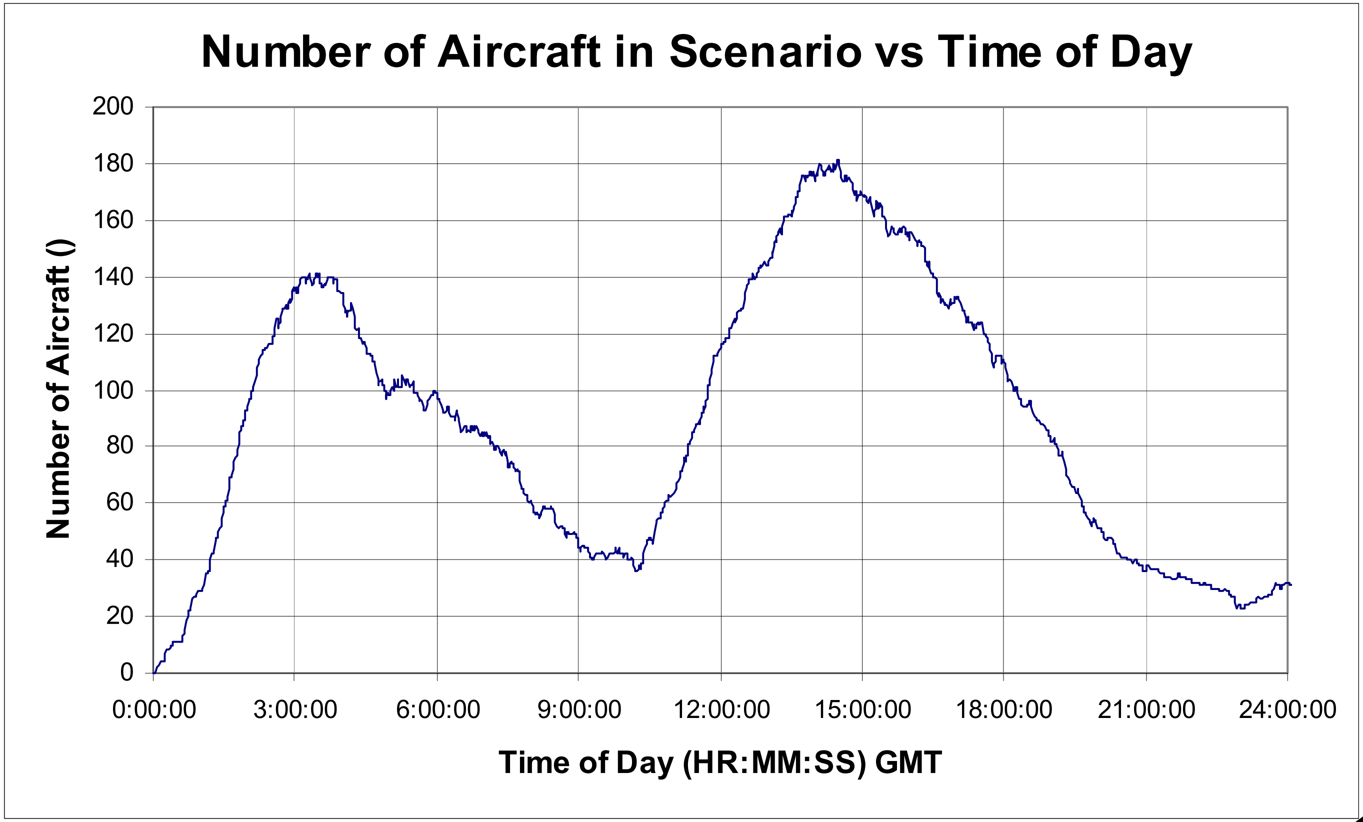
FAA flight data from July 18, 2001



Maximum Geometrical Corridor Capacity

– 60 NMi Separation	314
– 45 NMi Separation	546
– 30 NMi Separation	1197
– 15 NMi Separation	4674

AMSS Link Budget Assumptions (Iridium Like)

- 8° minimum elevation angle
- 42.43 W average transmitter power
- 3dB of additional losses
- QPSK modulation
- 1e-9 BER
- Zenith Distance of 780 km
- Horizon Distance of 2460 km
- Frequency of 1.623 GHz
- Satellite G/T of -16.315 dB/K
- Burst Data Rate of 50 kbps

System Refresh Period

- The amount of time that is required for all of the aircraft in the corridor to transmit their messages, one time.

- For aircraft separation reductions to occur safely, all aircraft in the corridor must transmit their position information within the maximum system refresh period.

System Refresh Period Factors

- Required Navigation Performance (RNP) to aircraft separation ratio
- Latency (delay from transmission to reception) of position message from aircraft to ATC
- Latency of warning message from ATC to aircraft
- Pilot and aircraft response delay from warning message reception at aircraft to aircraft separation stabilization
- Average aircraft speed
- Speed deviation between aircraft
- Standard deviation for GPS reported position
- Aircraft are not flying on the same path in opposite directions
- Aircraft will not arbitrarily change altitudes

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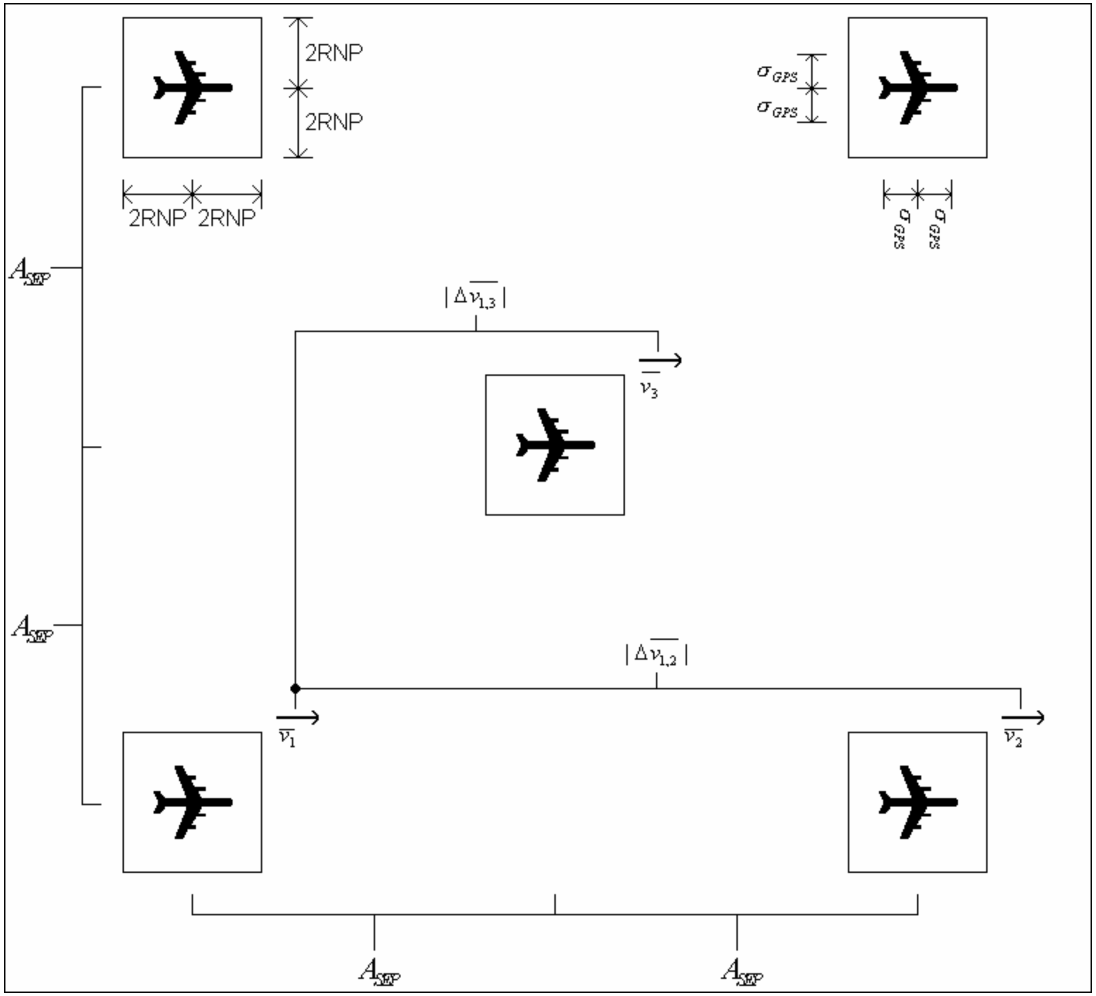

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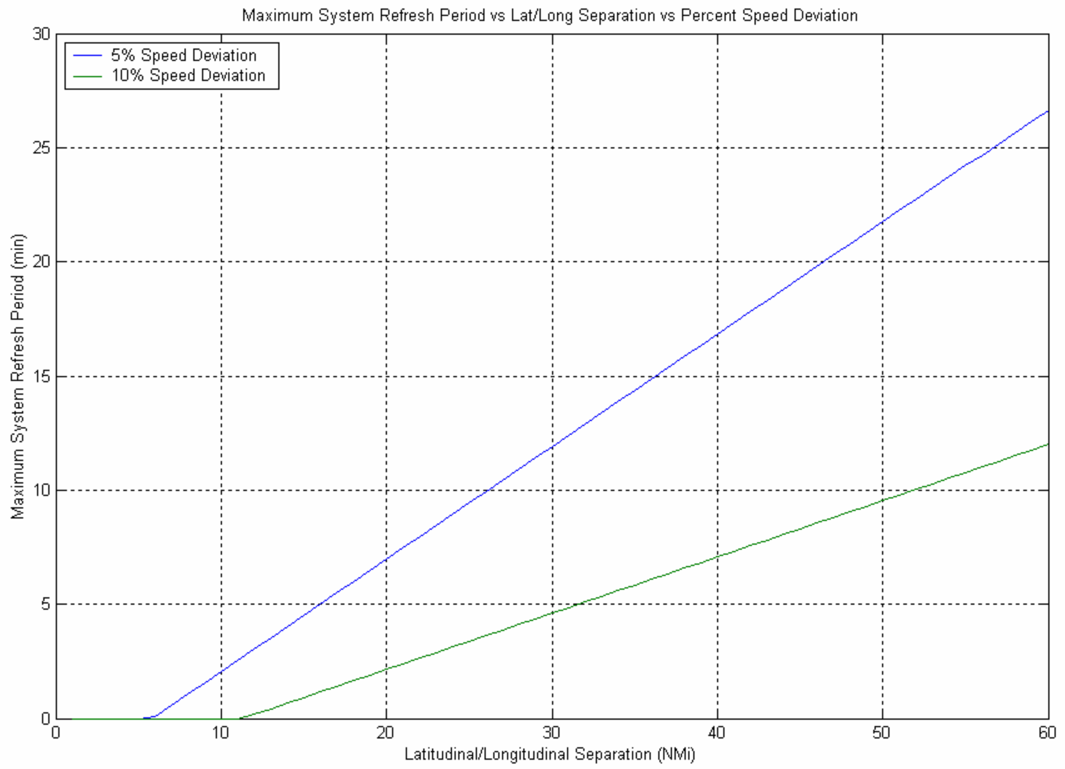
Maximum System Refresh Period vs. Separation and Speed Deviation



5 Percent Speed Deviation **10 Percent Speed Deviation**

Transmission Methods

- Method 1 – Single Aircraft Transmission at a Time
  - Case 1 – Own Data Transmission
  - Case 2 – Vicinity Data Transmission

- Method 2 – Maximum Aircraft Transmission at a Time
  - Case 1 – Own Data Transmission
  - Case 2 – Vicinity Data Transmission

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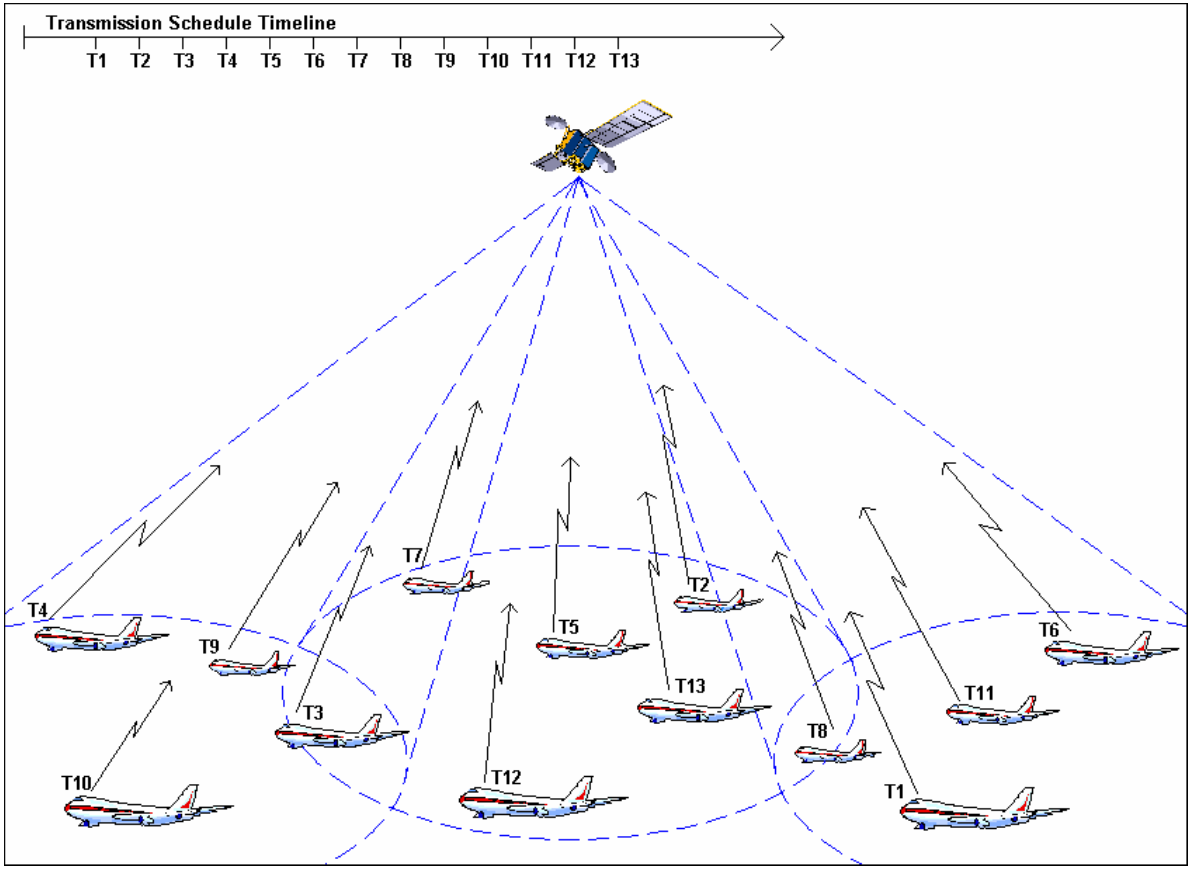
Method 1 – Case 1



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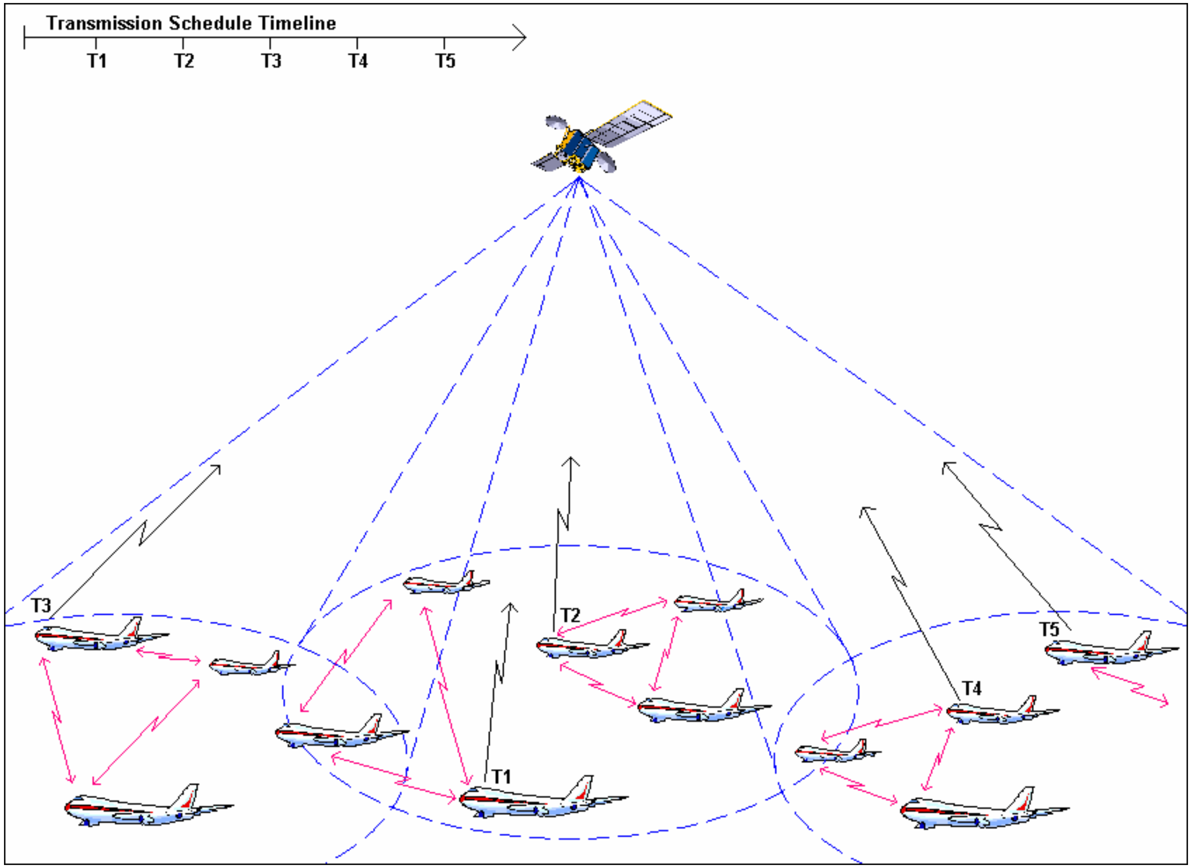
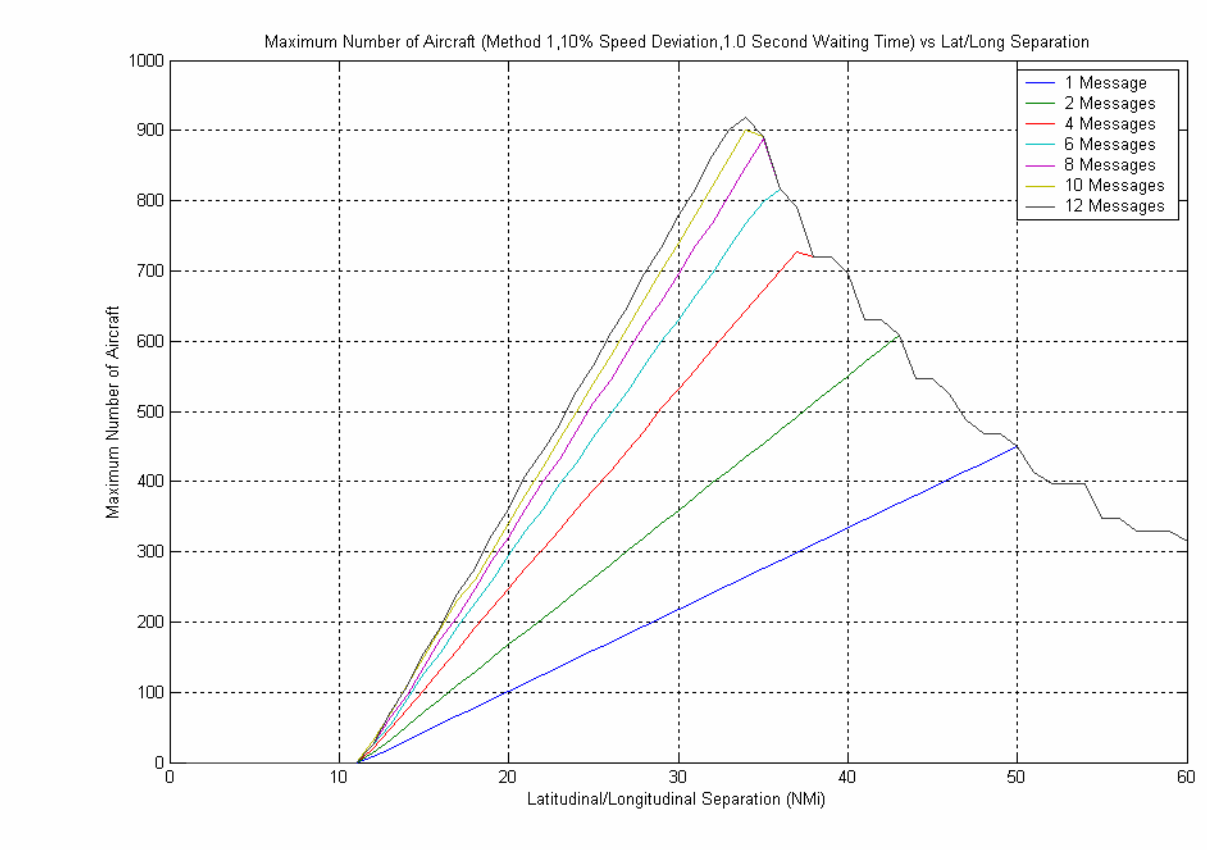
Method 1 – Case 2



Maximum Number of Aircraft – Method 1



Maximum Number of Aircraft – Method 1

Messages per Transmission	60 NMi	45 NMi	30 NMi	15 NMi
1	314	392	218	43
2	314	546	358	72
4	314	546	532	104
6	314	546	630	126
8	314	546	696	136
10	314	546	740	150
12	314	546	780	156

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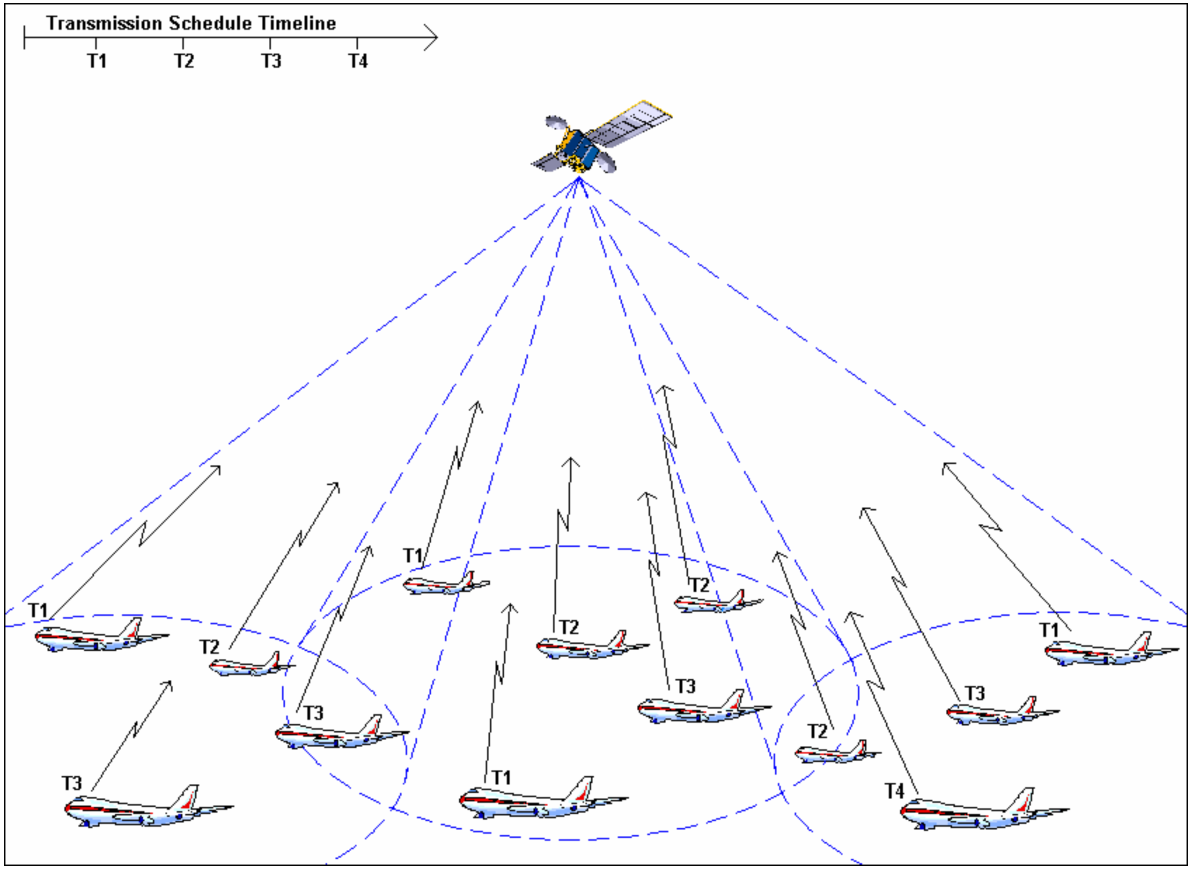
Method 2 – Case 1



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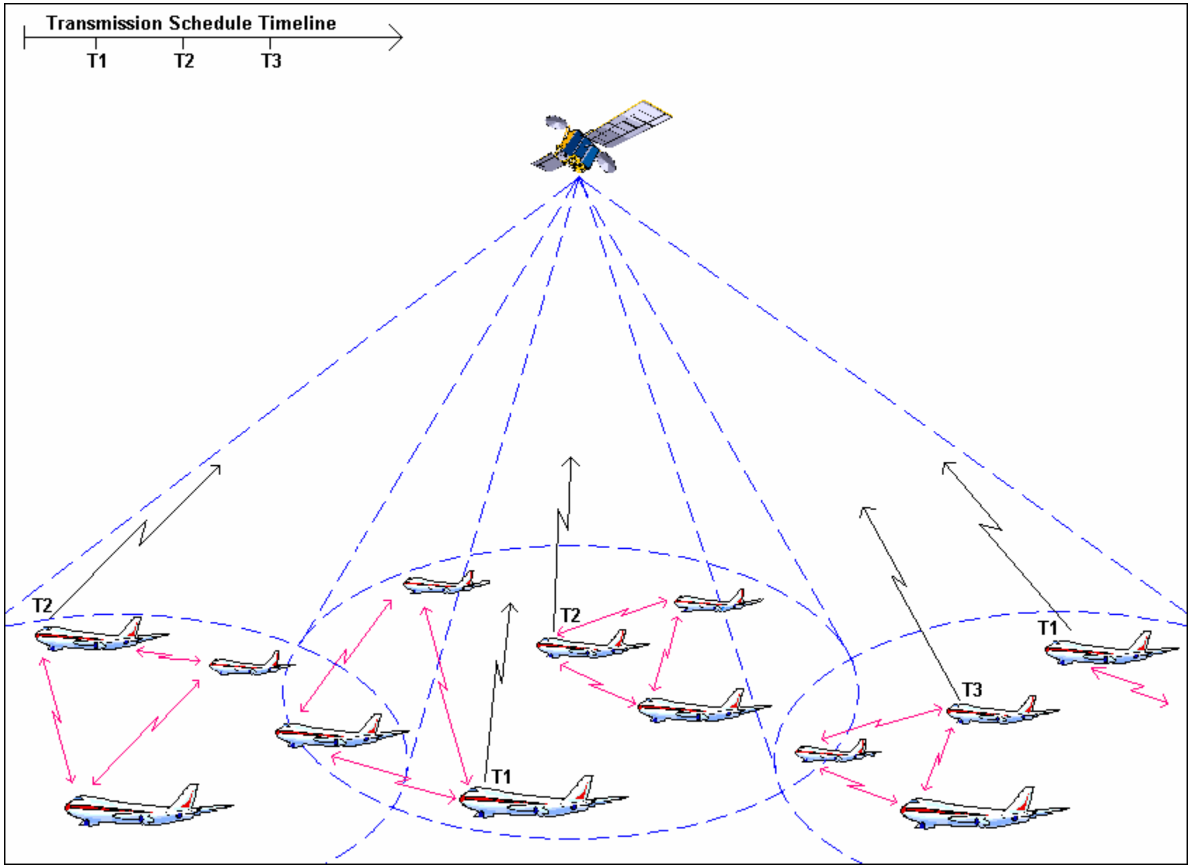
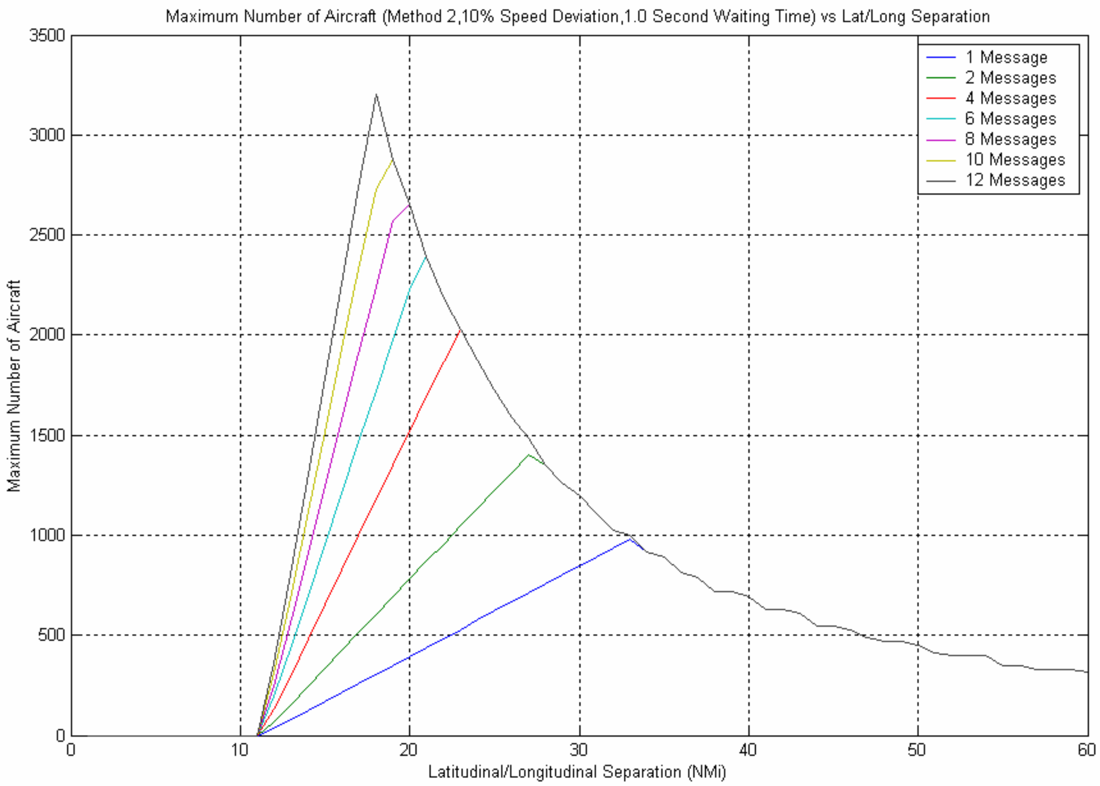
Method 2 – Case 2



Maximum Number of Aircraft – Method 2



Maximum Number of Aircraft – Method 2

Messages per Transmission	60 NMi	45 NMi	30 NMi	15 NMi
1	314	546	846	169
2	314	546	1197	334
4	314	546	1197	652
6	314	546	1197	954
8	314	546	1197	1248
10	314	546	1197	1520
12	314	546	1197	1788

Summary

– On a theoretical level:

- Several AMSS/ADS methods show potential
- Communications capacity can meet requirements
- Sufficient surveillance data can be provided

– Taking all that into account:

- Reduced separations might be considered, but level of separation will depend strongly on procedures